Final Bottling Filtration

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Final Bottling Filtration

- The final bottling filtration is the only and ultimate guarantee for a finished wine’s quality and stability.
- Integrity testing the membrane ensures micro retention.
• Overview of filters and types
• Membrane differences
• Total Costs of Filtration
• Optimization and Operation
• Cleaning and Sterilization
• Integrity Testing
• Troubleshooting
Two Types of Filter Structure

**Depth Filter**
- Thick and fibrous
- High dirt holding

**Membrane Filter**
- Thin single-layer film
- Low dirt holding
Two Types of Filter Performance

**Depth Filter**
- Random pore structure
- 50 to 99.9% retention
- Flexible structure
- Particle unloading

**Membrane Filter**
- Controlled pore structure
- >99.9% retention
- Rigid structure
- No particle unloading
<table>
<thead>
<tr>
<th><strong>Depth Filter</strong></th>
<th><strong>Membrane Filter</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benefits:</strong></td>
<td><strong>Benefits:</strong></td>
</tr>
<tr>
<td>Higher holding capacity</td>
<td>High retention reliability</td>
</tr>
<tr>
<td>Lower cost per filter unit</td>
<td></td>
</tr>
<tr>
<td><strong>Problem:</strong></td>
<td><strong>Problem:</strong></td>
</tr>
<tr>
<td>Low retention</td>
<td>Lower holding capacity</td>
</tr>
<tr>
<td>No integrity test</td>
<td>Higher cost per filter</td>
</tr>
<tr>
<td><strong>Best use:</strong></td>
<td><strong>Best use:</strong></td>
</tr>
<tr>
<td>Remove bulk particles</td>
<td>Remove micro-organisms</td>
</tr>
<tr>
<td>(PREFILTERS)</td>
<td>(FINAL FILTERS)</td>
</tr>
</tbody>
</table>
Filter Types and Selection

Optimized Filtration Train

Ideal

Depth
Surface
Dry
## Pore Size Removal

<table>
<thead>
<tr>
<th>Removed entities</th>
<th>Final filter requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Cryptosporidium</td>
<td>1.0 µm filter</td>
</tr>
<tr>
<td>- Particles</td>
<td></td>
</tr>
<tr>
<td>- Brett</td>
<td></td>
</tr>
<tr>
<td>- Yeast</td>
<td>0.65 µm filter</td>
</tr>
<tr>
<td>- Some bacteria</td>
<td>0.45 µm filter</td>
</tr>
<tr>
<td>(All for wine and beer)</td>
<td></td>
</tr>
<tr>
<td>- All bacteria</td>
<td>0.2 µm filter</td>
</tr>
<tr>
<td>- Virus</td>
<td>0.1 µm filter</td>
</tr>
</tbody>
</table>
Cartridge Manufacturing

- What Manufacturing Differences Might you See?
  - Pharma-grade clean room
  - Pharma-grade materials
    - High temp ok, no oils, extractables
  - Semi-automated manufacturing
  - Stringent QC/QA controls
    - 100% testing, high safety factors, no re-work
  - Edge lamination
  - Spinning end cap during bonding
  - Pull back of support layers during sealing
  - Dual-viscosity end-cap (MP only)
  - 100% cartridge IT testing (prefilters too)
  - Increased membrane area/number of pleats
    - Some filters have 30% less membrane
    - Like having 8 filters in a 12-rd
The Membranes

- PVDF and PES are cast polymer membranes
  - PVDF is polyvinyl difluoride
  - PES is polyether sulfone
- The membranes have different structures
  - PVDF is a symmetric membrane
  - PES is an asymmetric membrane
- The membranes have different surface treatments
Membrane Cross-Sections

PES

Flow

PVDF
The Membranes

- Membrane chemistry and surface treatment affect the properties and operation of the membrane
  - Protein and color binding
  - Chemical stability
  - Cleanability
- Symmetry also affects many important membrane properties and operation
  - Membrane strength
  - Flow rate and pressure drop
  - Integrity testing
  - Surface tension of fluids
Why we recommend PVDF?

- Less color and protein removal
- More cleaning cycles before loss of permeability
- Slower loss of permeability
- Higher general robustness
- More reliable IT testing
- Increased throughput offsets higher unit cost

Lower Total Costs of Filtration
Gallons throughput per filter or change-out is the key metric to monitor.
Total Costs of Filtration

- Each scenario is a little different
  - How to value liquid wine?
  - What does the operation look like?
  - After throughput, frequency of plugging (even when not leading to a change out) is important

- Three angles to look at
  - (1) A higher throughput filter can usually directly match or beat a lower quality and priced cartridge based on fewer cartridges used
  - (2) The Total Costs of Filtration savings (wine loss, downtime, utilities, operator labor) are usually comparable to total filter spend
  - (3) A single QA incident costs many years of filter purchases
The Costs of Filtration

- Membrane filters are expensive when they prematurely plug …
- … They are inexpensive when they achieve their full life
  - A 30” Vitipore II Plus could filter 100,000+ gallons
  - The cost at that level for filtration is $.004 per gal or 8 hundredths of a cent per bottle
- Size your final Vitipore II Plus Filter at 6 to 10 gpm per 30 inch cartridge, rounding to the nearest housing size as shown in the table.
- Recommend using one size larger than the final filters for the Bevigard prefilters.
- Water prefiltration should be sized 1.5x final filtration.

<table>
<thead>
<tr>
<th>Flow Rate</th>
<th>Housing Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 gpm</td>
<td>1-Rd 30&quot;</td>
</tr>
<tr>
<td>10-30 gpm</td>
<td>3-Rd 30&quot;</td>
</tr>
<tr>
<td>30-50 gpm</td>
<td>5-Rd 30&quot;</td>
</tr>
<tr>
<td>50-80 gpm</td>
<td>8-Rd 30&quot;</td>
</tr>
<tr>
<td>80-120 gpm</td>
<td>12-Rd 30&quot;</td>
</tr>
</tbody>
</table>

- Clarification housings and other applications need individual sizing.
Parallel (Dual) Filtration Skids

- Allows continuous bottling in the event of plugging, cleaning, wine or tank changes, etc.
- Allows for longer cleaning cycles
- Allows for specialized cleaning cycles (e.g., citric acid to remove flavors or water deposits)
Frequently Vent Housings
- Especially on start-up and CIP
Monitor differential pressures
Track gallons throughput
**Plugging Mechanisms**

**Types of Particles**

- **Hard**
  - Sand, D.E., Dust, Metal Fines
  - Easy to Filter

- **Deformable**
  - Colloids, Gels, Microbial Products, Clays
  - Difficult to Filter
Conclusions on Filter Plugging

Filter plugging depends on:
- The type of filter used (depth/membrane, pore size rating)
- The quality/filterability of the feed
- The speed (flow rate) at which particles are deposited on the filter

Filter plugging’s visible result is:
- Increase in Pressure Drop across the filters over time

Filter plugging can be delayed by:
- Consistent operation
- Feed preparation
- Controlling water quality used for cleaning
- Proper Cleaning regimens
Filter Cleaning

→ Purposes:
  - Improve overall filtration costs by extending filter life
  - Eliminate flavor and color carryover

→ Limiting factors:
  - Bound proteins at high temperature
  - Nature of plugging materials (inorganics not cleanable – Si, Al)
Filter Cleaning

Cleaning Extends Filter Life

Final filter $\Delta P$ increase from installation

Cleaning

Cleaning

Cleaning

Volume filtered

Filter Change-Out
Filter Cleaning

- **Recommended procedure:**
  - Cold water rinse; at least 10 minutes
  - Hot water cleaning and/or sanitation
  - Cold water cool-down
- Use the same flow rate as the process is run
- Gradual warm and hot water temperature increases to the final 180 F offers more efficient cleaning
Filter Sanitization and Storage

• Purpose:
  – Kill micro-organisms to prevent bioburden growth
  – Prevent biofilm attachment to stainless steel surfaces (piping, housing)

• Limiting factors:
  – Contact time, temperature
The maximum allowable pressure drop across the cartridges varies with the fluid temperature.

<table>
<thead>
<tr>
<th>Fluid temperature</th>
<th>Maximum DP allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>25°C (77°F)</td>
<td>80 psid</td>
</tr>
<tr>
<td>80°C (176°F)</td>
<td>25 psid</td>
</tr>
<tr>
<td>93°C (200°F)</td>
<td>20 psid</td>
</tr>
</tbody>
</table>

135°F is the temperature at which many proteins are baked onto the membrane – always cold and/or warm water rinse before reaching this temperature.

Nothing, outside of terrible feed quality, can impact filter life more.
• Water used for cleaning and sanitation must be softened and filtered prior to use.
• Water can be very high in plugging materials and build un-cleanable deposits onto the membrane.
• Facilities that have properly cleaned water have seen as much as a 25% decrease in cartridge filter spend.
Why Perform an Integrity Test?
- Assurance of filter retention and bottled product quality

Method to Detect System Leaks From:
- Improper filter installation
- Damaged filters
- Damaged filter o-ring or other gasket seal
When to Perform an Integrity Test?

- Whenever new final filters are installed
  - To ensure proper installation
- After every cleaning and sanitation procedure
  - Especially at high temperature
  - Most common time of cartridge damage
- After long term storage
  - To ensure integrity has been maintained
- End of run
  - To show bottled product is safe
- When post-final filter tests show micro counts
  - Are the filters by-passing / non-integral?
  - Is there post-filter contamination?
Troubleshooting

• Vitipore II filters are all double integrity tested in manufacturing with proprietary gas
  – No defective cartridges or membrane defects leaving the plant
• Carefully inspect shipping boxes for damage
• If ever an IT failure, contact Gusmer and arrange for a filter evaluation.
  – Every IT failure will be verified and sent back to Millipore for analysis free of charge if needed
• Filter end of life should be throughput based – never IT failure
Troubleshooting

• In multi-round setups, with good clarification, we want each Vitipore II to get 100,000 gallons throughput over its life.
  – When protected by Bevigard M
  – Wine must be properly prepared and clarified
  – Water should be filtered, softened
  – Cleaning must be carried out efficiently

• Contact Gusmer for recommendations on filter optimization
  – Always track throughput!!

• We’ve helped customers who super-optimize get as high as 300,000 gallons per 30” in multi-rounds (>3M per 12-Rd)
  – This is rare but shows the capacity for filter optimization
Thank you, Questions?